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THE COUNTRY CODE AND NUMBER OF YOUR PRIORITY APPLICATION, TO BE USED FOR FILING ABROAD UNDER THE PARIS CONVENTION, IS *US60/513,172*

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PROVISIONAL PATENT APPLICATION UNDER §111(b)	*Attorney Docket No.*	018778-9206
	First Named Inventor	
	Aaron Kiser	
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60/513172
102103

Mail Stop PROVISIONAL PATENT APPLICATION
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Sir:

Enclosed for filing is a complete provisional patent application entitled "DRIVE MECHANISM FOR A BI-FOLD WHEELCHAIR RAMP" invented by:

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and including the following documents:

Specification including Claims - 9 pages
Abstract of the Disclosure
Drawings - 33 sheets
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Respectfully submitted,

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Wkg Atty. DRM
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PROVISIONAL PATENT APPLICATION FOR DRIVE MECHANISM FOR A BI-FOLD WHEELCHAIR RAMP

FIELD OF THE INVENTION

[0001] The invention relates to wheelchair ramp systems. More particularly, the present invention relates to a linear actuation drive mechanism for operating a vehicle wheelchair bi-fold ramp.

BACKGROUND OF THE INVENTION

[0002] Wheelchair ramp systems for vehicles are well known, and have been employed to enable persons who are physically challenged or otherwise have limited mobility to board and leave a vehicle. Various wheelchair ramp systems have been proposed that include electrical, pneumatic, or hydraulic drive systems. Additionally, various drive mechanisms have been proposed that effect rotary actuation, linear actuation, or other. Irregardless of whether the drive mechanism is electrical, hydraulic, rotary, or linear, it is desirable to maintain a constant speed and torque throughout the entire range of motion of the ramp. As shown by the brief discussion of the prior art below, effectuation of constant speed and constant torque actuation of a wheelchair ramp has been elusive.

[0003] U.S. Patent No. 5,391,041 to Stanbury et al. for "Hydraulically Operated Bus Ramp Mechanism", issued February 21, 1995 discloses a linear hydraulic drive system with a transmission means for converting linear motion into rotational motion. The disclosed transmission means is affixed to the ramp hinge and includes a cam with an approximate involute curve slot so the ramp may rotate through an angle of more than 180 degrees with a single piston stroke of the hydraulic cylinder. Due to the shape of the curved slot, it is readily apparent that the ramp will initially deploy slowly from a stowed state, and will move faster when the cam driver nears the inner end of the slot. Similarly, as the cam driver travels along the curved slot, the torque required to drive the transmission varies. In this way, the ramp deploys and stows with varying speeds and torque requirements making its operation somewhat unpredictable. Additionally, the transmission means is further disadvantaged as it requires custom parts which are not readily available.

[0004] U.S. Patent No. 6,179,545 to Petersen, Jr. et al. for "Flip-Over Ramp" issued January 30, 2001 discloses a hydraulically driven, rotary actuated ramp system. The disclosed rotary actuator system improves somewhat on the Stanbury et al. system by including readily available "off-the-shelf" components (as opposed to the cam with an involute curve slot), but does not provide a self-contained ramp actuation system. For example, a hydraulic control unit 22 is shown within the enclosure 12, but hydraulic lines (not labeled) are shown extending through the side 60 of the enclosure where they intuitively connect with the vehicle hydraulic system, or an independent hydraulic power unit located elsewhere in the vehicle. Such hydraulic systems often require convoluted line routing which is prone to leaking and is difficult to maintain, troubleshoot, and repair.

[0005] As evidenced in the prior art discussed above, hydraulic driven wheelchair ramp systems have become more prevalent due to their durability, reliability, and ability to be integrated with existing vehicle hydraulics. However, recent consumer sentiment has tended toward a self contained, drop-in package for aftermarket installed hydraulic wheelchair ramp systems. It would therefore be advantageous to locate the hydraulic power unit (i.e., motor, pump, reservoir, etc.) within the mounting enclosure to consolidate the system so that routing of hoses and lines is simplified, ramp operating noise is reduced, and potential fluid leakage is contained. In light of the foregoing, there exists a long felt need for a simplified and improved self-contained hydraulic linear drive system for wheelchair ramps that maintains a constant speed and torque throughout the entire range of motion of the ramp.

SUMMARY OF THE INVENTION

[0006] One embodiment of the invention provides a hydraulic linear drive system for reversibly operating a folding, flip-out wheelchair ramp. The folding ramp preferably has two folding sections which are hingedly connected to each other and to a mounting enclosure located within the vehicle threshold. When stowed, the ramp sections fold substantially flat upon themselves on top of the mounting enclosure in the threshold. When deployed, the ramp sections pivot outward from the threshold and unfold to form an angle of slightly more than 180 degrees with respect to the threshold plane. The hydraulic drive system includes a linear actuator such as a hydraulic cylinder for deployment and stowage of the ramp. The drive system includes a gear rack affixed to the actuator arm which mates with and drives a spur gear. The spur gear is attached to a first link of a multi-link assembly, which preferably

includes two following links, the following links pivotally attached to each other and to each of the ramp folding sections for deploying and stowing the foldable two-portion ramp. Additionally, the hydraulic power unit is preferably located within the mounting enclosure to consolidate the hydraulic system. An alternative embodiment includes an electric linear actuator.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] The present invention is described with reference to the accompanying figures which illustrate embodiments of the present invention. However, it should be noted that the invention as disclosed in the accompanying figures and appendices is illustrated by way of example only.

[0008] FIG. 1 is a perspective view of an exemplary bifold ramp with drive system components shown.

[0009] FIG. 2 is a top view of the drive elements of FIG. 1 within the ramp mounting enclosure.

[0010] FIG. 3 is a side view of the drive elements of FIG. 2.

[0011] FIGs. 4-8 are side and perspective views of the exemplary bifold ramp and drive system of FIG. 1 in a first intermediate position.

[0012] FIGs. 9-14 are side and perspective views of the exemplary bifold ramp and drive system of FIG. 1 in a second intermediate position.

[0013] FIGs. 15-20 are side and perspective views of the exemplary bifold ramp and drive system of FIG. 1 in a fully deployed position.

[0014] FIGs. 21-24 are side and perspective views of the exemplary bifold ramp and drive system of FIG. 1 in a fully stowed position.

[0015] FIGs. 25 and 26 are perspective views of the interior of the ramp mounting enclosure showing an exemplary pump cutoff switch assembly.

[0016] FIG. 27 is an electrical schematic for the inventive ramp drive system of FIG. 1.

[0017] Appendix A is technical specification sheets for one family of exemplary electric linear actuators.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

[0018] Referring now to FIGs. 1 through 26, and particularly FIGs. 1 through 3, a drive system for a bifold vehicle wheelchair ramp is shown. Figures which are directly referred to herein have been numbered with reference numerals. Figures without reference numerals illustrate the same preferred embodiment as the numbered figures, consequently, common elements shown in all of the figures shall be thought to be numbered accordingly. Referring to FIG. 1, an exemplary bifold ramp assembly is shown. For ease of reference, the modifier "inboard" shall refer to a direction toward the vehicle, whereas the modifier "outboard" shall refer to a direction away from the vehicle. The ramp assembly as shown includes an inboard ramp section 34, an outboard ramp section 36, and a mounting enclosure 10 which is typically installed within the floor of a vehicle threshold so that persons who are physically challenged or otherwise have limited mobility may board and leave a vehicle, such as a minivan, bus, or the like. The mounting enclosure 10 includes a cover plate 12 which is preferably removable so that the ramp drive system within enclosure 10 may be serviced, and a pan 14 which is recessed into the vehicle floor. Preferably the drive system is a hydraulic type system which is fully enclosed within the enclosure 10. By fully enclosing the drive system including a hydraulic power unit (e.g., motor/pump combination), the wheelchair ramp system is substantially self contained and may be installed as a "drop-in" system. Additionally by fully enclosing the drive system, potential hydraulic fluid leaks will be contained within the pan 14, hydraulic line routing is minimized, and only electrical connections to the ramp system are required.

[0019] Attached to the inboard wall of the pan 14 is a fixed attachment point 15 which retains one end of a hydraulic cylinder 16. The fixed attachment point 15 as shown in FIGs. 1-3 is a spaced arrangement of two triangular-shaped portions with holes, although other shapes and arrangements may function similarly. Preferably, attachment point 15 is integrally formed with the pan 14 or welded thereon. The hydraulic cylinder 16 is fixedly retained by attachment point 15 by inserting a bolt, screw, or the like through each of the holes of attachment point 15

and a corresponding mounting hole of the cylinder 16. Thus retained, the cylinder 16 remains stationary during ramp operation.

[0020] The hydraulic cylinder 16 includes arm 18 which moves outboardly and inboardly to respectively deploy and stow the ramp. Attached to the outboard end of the arm 18 is a gear rack 20. As shown in FIG. 3, gear rack 20 is preferably a generally L-shaped element which is toothed along its elongated side. One exemplary gear rack is McMaster Carr part number 6295K152 (pitch 10; 5/8 thick; 4 feet long). The gear rack 20 meshes with a spur gear 22. One corresponding exemplary spur gear that works with the aforementioned exemplary gear rack is McMaster Carr part number 6325K38 (pitch 10; teeth 24; pitch dia 2.400"). Other exemplary spur gears and corresponding gear racks are available from Martin Sprocket & Gear, Inc. of Arlington, Texas. Spur gear 22 is mounted to shaft 24 which may be either fixed or free (i.e., the shaft may rotate in response to spur gear rotation). As shown in FIGs. 2 and 3, a support plate 23 rigidly affixed to the bottom of pan 14 includes a central hole which accepts and retains a first end of shaft 24. Similarly, a hole in the left side wall of pan 14 accepts and retains a second end of shaft 24, holding it substantially horizontal.

[0021] As shown in FIG. 1, a driving link 26 is the first link in a multi-link arrangement. Referring to FIG. 3, the driving link 26 is bent at a slight angle proximate to its pivot end which is inserted onto shaft 24 and fixedly attached to spur gear 22. As is obvious, when cylinder 16 is hydraulically actuated to extend arm 18, the gear rack 20 advances linearly in the outboard direction. Linear advancement of the gear rack 20 directly translates to clockwise rotational motion of the spur gear 22 and attached driving link 26. Since it would be undesirable if the gear rack 20 were to disengage from the spur gear 22, one of the support members 11 for the cover plate 12 is operable to serve as a guide. As shown in FIG. 25, the support member 11 adjacent the cylinder 16 is positioned above the gear rack 20 and is fixedly attached to the support plate 23. The support member 11 adjacent the cylinder 16 is preferably channel-shaped to accept the gear rack 20 and prevents lateral and vertical movement of the gear rack 20 so the ramp does not become disengaged from the drive system. In addition, the channel-shaped support member 11 may include one or more bearings or the like such as VHMW plastic bearings that have a low coefficient of friction, good impact and abrasion resistance, and inherent lubricity. By fully extending the arm 18, the driving link 26 arcuately pivots through approximately 180 degrees about the shaft 24.

[0022] Referring back to FIG. 1, the distal end of driving link 26 is pivotably attached to a first end of the second link 28. The second link 28 is pivotably affixed to the sidewall of the inboard ramp section 34 midway the inboard and outboard edges of the ramp sidewall by pivot pin 42 which is near the second (outboard) end of the second link 28. Additionally, pivot pin 42 inhibits the links from moving laterally away from the ramp, thereby preventing their deformation. The second end of the second link 28 is pivotably affixed to the first end of a third link 30, and the second end of the third link 30 is pivotably retained by pivot plate 40 which is attached to the inboard end of the sidewall of the outboard ramp section 36. As shown, the inboard ramp section 34 is connected to the mounting enclosure at the vehicle threshold by a hinge 32 which is a piano hinge or the like. The hinge 32 allows the inboard ramp section 34 to fold substantially flat against the mounting enclosure cover plate 12. Similarly, the outboard ramp section 36 is connected to the inboard ramp section 34 by a hinge (not shown) which allows the outboard ramp section 36 to fold substantially flat against the underside of the inboard ramp section 34.

[0023] Thus arranged and pivotably connected to each other and to their respective ramp sections, the links of the multi-link assembly are operable to deploy and stow the ramp in accordian-like fashion. Starting from a fully stowed and folded state, the drive link 26 pivots arcuately upward and outward from the vehicle. Subsequently, the distal end of drive link 26 acts on second link 28 with an upward and outboard force. As the second link 28 is affixed to the inboard ramp section 34 at pivot pin 42, the second link 28 drives the inboard ramp section 34 upward and outward from the vehicle. Additionally, the second link 28 acts on the third link 30 so that the outboard ramp section 36 unfolds from the inboard ramp section 34. When the inboard ramp section 34 becomes oriented substantially vertical and slightly outboard, the second link 28 further acts as a lever arm about pivot pin 42 to drive the third link 30 substantially parallel to the inboard ramp section 34 so that the outboard ramp section 36 pivots upward such that the ramp sections become coplanar. Operation of the ramp is further illustrated by referring to FIGs. 4-24. One may simulate ramp operation in "flip book" fashion by selecting all figures having a particular view of interest of the ramp system (e.g., FIGs. 21, 4, 9, and 15 in that order illustrate a side view full deployment of the ramp from a stowed state).

[0024] Moreover, it would be advantageous to sense the position of the ramp so that after it was driven to a substantially vertical position, it may float down under gravity power. This "gravity-down" operation allows for reduced consumption of vehicle electric power, and also reduced wear and tear on a hydraulic power unit which thereby extends operating life. In addition, a semi-manual operation of the ramp may be effected by the use of the hand holes 38 shown in FIG. 1. Referring now to FIG. 25, the ramp drive system components including hydraulic power unit 100 and hydraulic lines 200 are shown inside the mounting enclosure 10. As shown, the inside of support plate 23 (i.e., the side opposite the spur gear and drive link) includes an arrangement of sensors or switches that may be actuated, for example, by an arrangement of one or more cams attached to the inside portion of the shaft 24. Referring to FIG. 26, an exemplary cam and switch arrangement is shown. A first switch 52 may be operable to turn off the hydraulic power unit 100 when the ramp is substantially vertical during deployment, whereas a second switch 62 may be operable to turn off the hydraulic power unit 100 when the ramp is substantially vertical during stowage, or vice versa. A first and second cam 50 and 60 are operable to actuate the first and second switches 52 and 62, or second and first switches 62 and 52, respectively. Referring now to FIG. 27, the sensors or switches may be "hard wired" in the hydraulic power unit 100 electrical circuit, or alternatively may be linked to a controller, which may be a programmable logic controller, microprocessor controller, or the like, so that the power unit 100 may be shut off when respective sensors are actuated during deployment and stowage so the ramp may gravity-down.

[0025] While a hydraulic drive system is discussed above as an exemplary embodiment, an electric drive system may be substituted as an alternative. One exemplary family of electric linear actuators is the Electrak series available from Warner Electric of South Beloit, IL. Technical specification for such exemplary electric linear actuators may be found in Appendix A. Preferably the electric linear actuator includes a ball bearing screw. To enable the electric linear actuator to backdrive so the ramp may "gravity down", a "load holding break" may need to be disabled.

[0026] Preferred embodiments of this invention are described herein. Variations of those preferred embodiments may become apparent to those of ordinary skill in the art upon reading the foregoing description. The inventors expect skilled artisans to employ such variations as appropriate, and the inventors intend for the invention to be practiced

otherwise than as specifically described herein. Accordingly, this invention includes all modifications and equivalents of the subject matter recited in the claims appended hereto as permitted by applicable law. Moreover, any combination of the above-described elements in all possible variations thereof is encompassed by the invention unless otherwise indicated herein or otherwise clearly contradicted by context.

WHAT IS CLAIMED IS:

1. A drive system for a vehicle wheelchair ramp wherein the ramp comprises one or more folding sections, the drive system comprising:

a linear actuator for actuating deployment and stowage of a wheelchair ramp, the actuator comprising an arm;

a gear rack attached to the linear actuator arm;

a gear meshing with said gear rack for converting linear motion to rotational motion; and

a link assembly comprising:

a driving link coupled to the gear; and

one or more following links;

wherein each of the following links is pivotably attached to one of the folding sections.

2. A self contained, drop-in vehicle wheelchair ramp assembly comprising:

a mounting enclosure comprising:

a pan for recessing into a vehicle floor; and

a removable cover plate;

a wheelchair ramp pivotably affixed to the outboard side of the mounting enclosure; and

a ramp actuating drive system disposed within the mounting enclosure.

ABSTRACT

Disclosed is a drive system for reversibly operating a folding, flip-out wheelchair ramp. The folding ramp preferably has two folding sections which are hingedly connected to each other, and one to a mounting enclosure located within the vehicle threshold. The hydraulic drive system includes a linear actuator, such as a hydraulic cylinder, and a gear rack affixed to the actuator arm which meshes with a spur gear. The spur gear is attached to a first driving link of a multi-link assembly, which preferably includes two following links, the following links being pivotally attached to each other at their ends, and to each of the ramp folding sections for deploying and stowing the ramp. Additionally, the hydraulic power unit is preferably located within the mounting enclosure to consolidate the hydraulic system. An alternative embodiment includes an electric linear actuator.

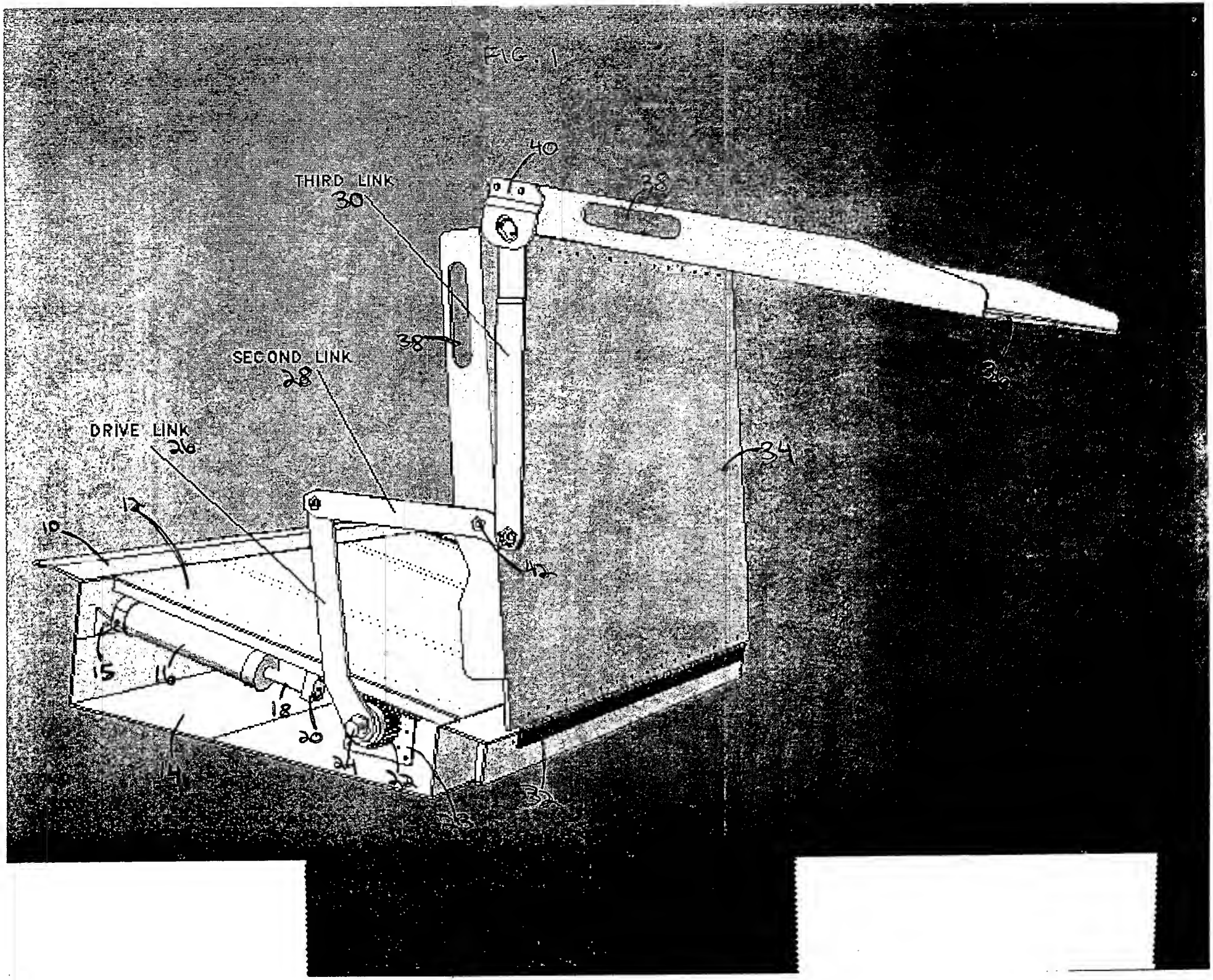
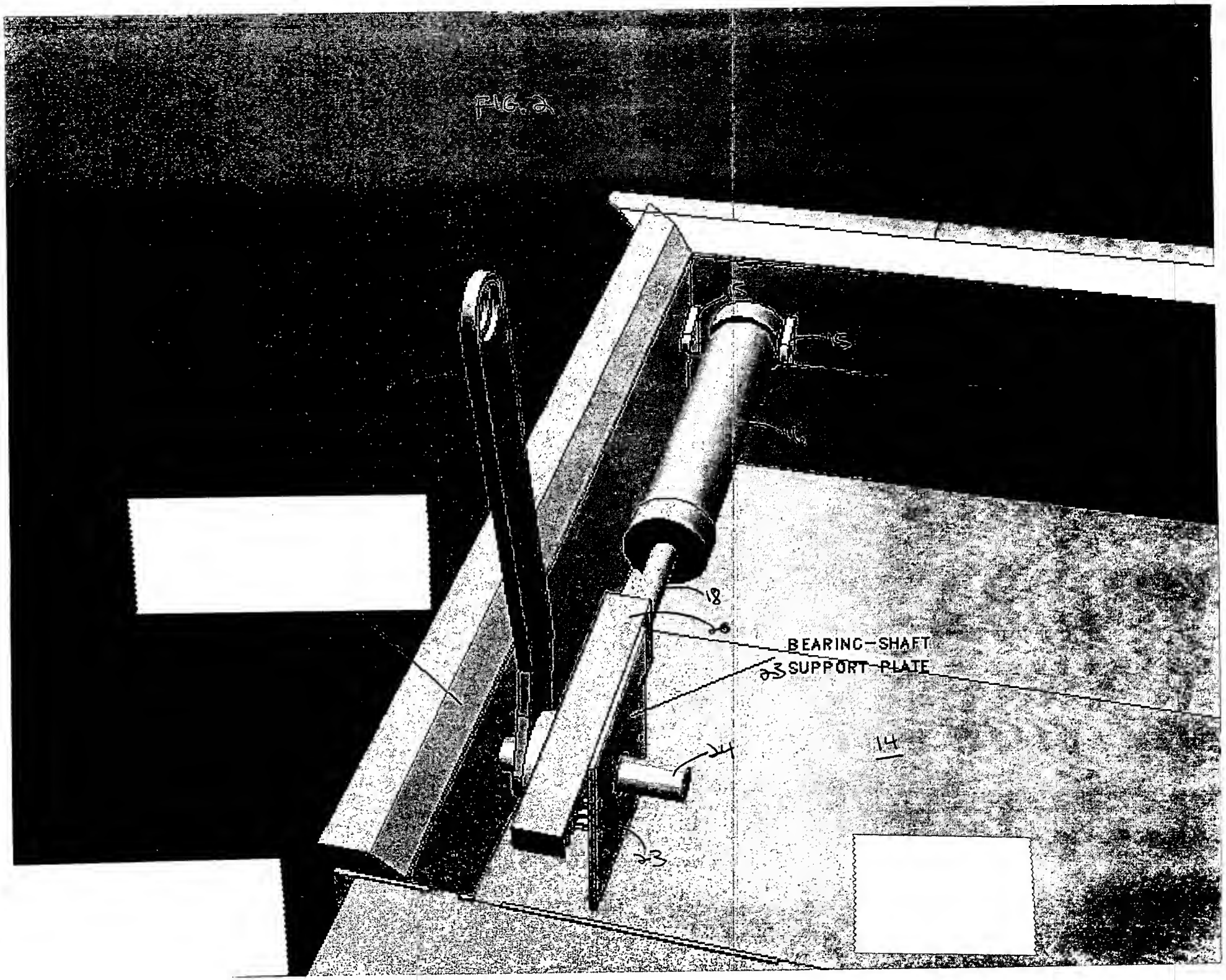


FIG. 1
THIRD LINK
30
SECOND LINK
28
DRIVE LINK
26
40
38
38
32
34
10
12
15
16
18
20
24
22
36
42
44
32

FIG. 2



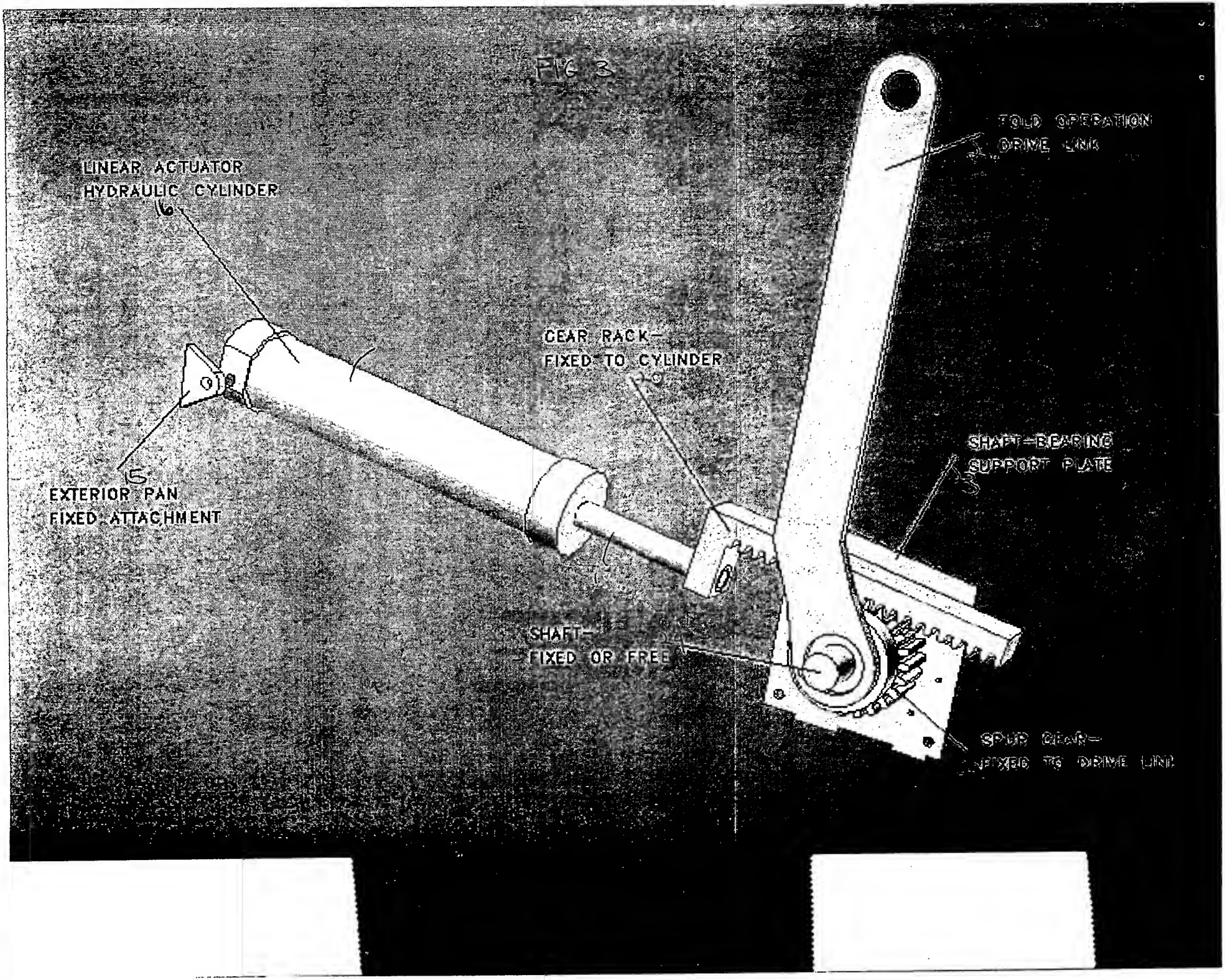


FIG 3
LINEAR ACTUATOR
HYDRAULIC CYLINDER
6
EXTERIOR PAN
FIXED ATTACHMENT
5
GEAR RACK—
FIXED TO CYLINDER
2
SHAFT—
FIXED OR FREE
FOLD OPERATION
DRIVE LINK
SHAFT—BEARING
SUPPORT PLATE
3
SPUR GEAR—
FIXED TO DRIVE LINK

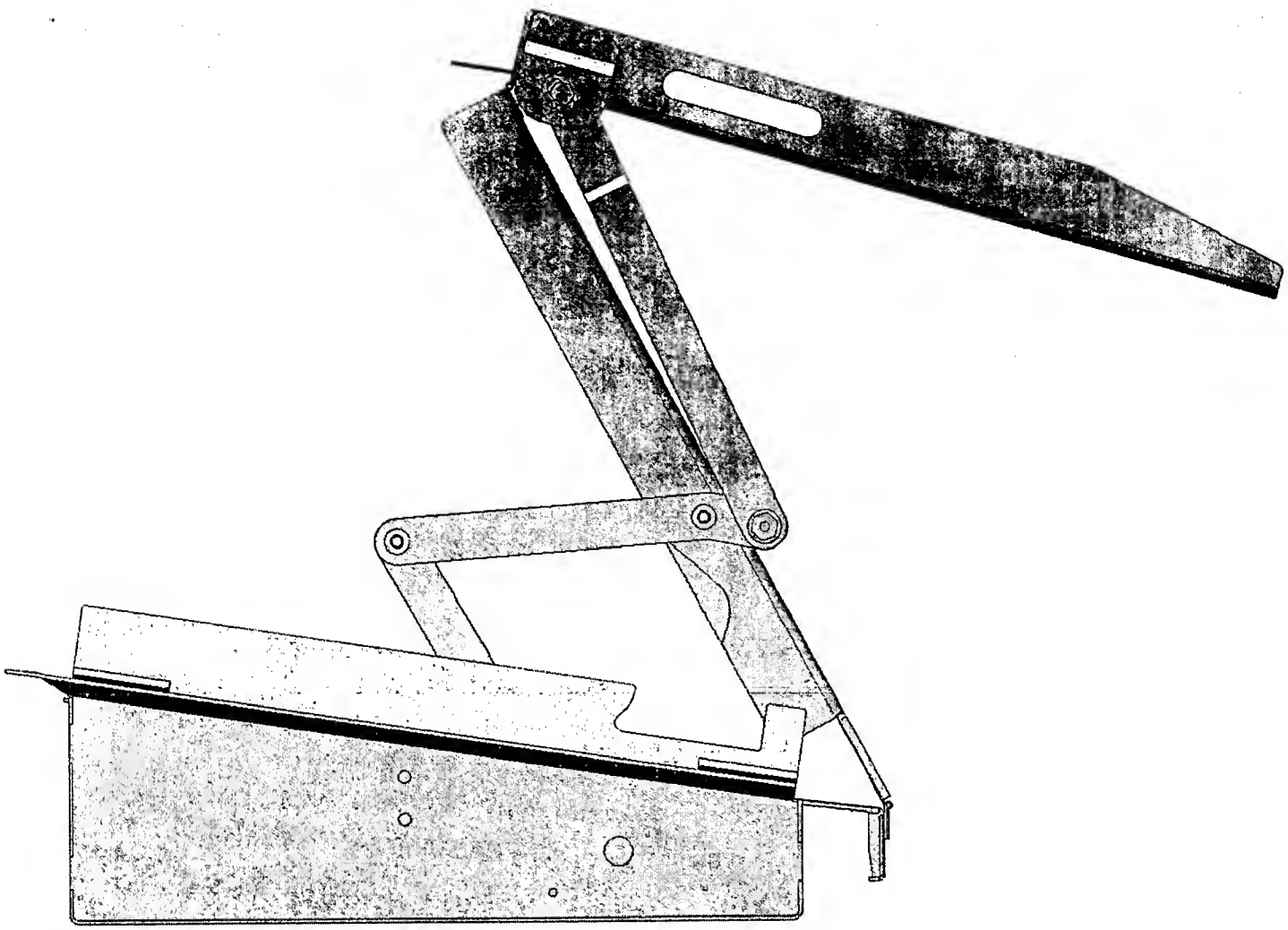


FIG. 4

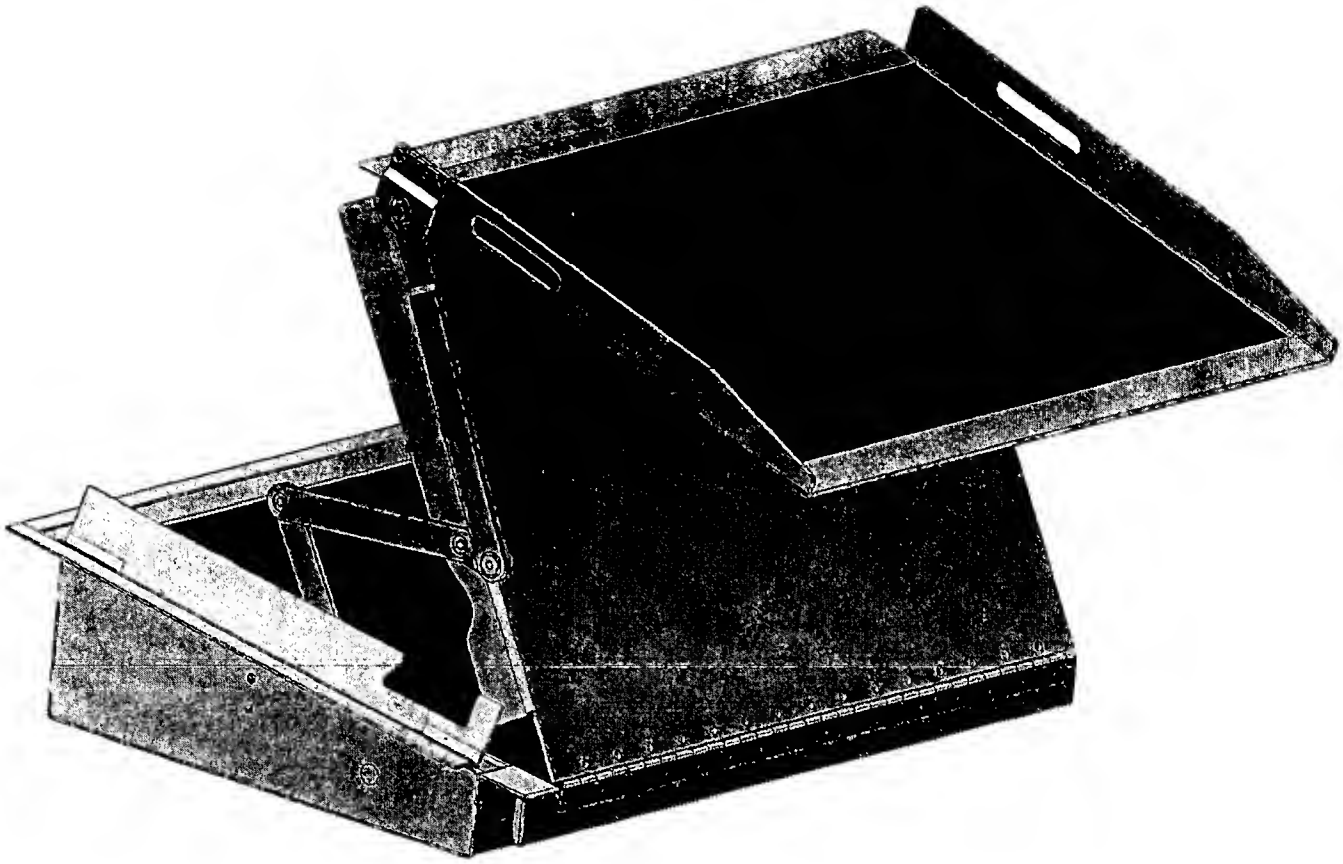


FIG. 5

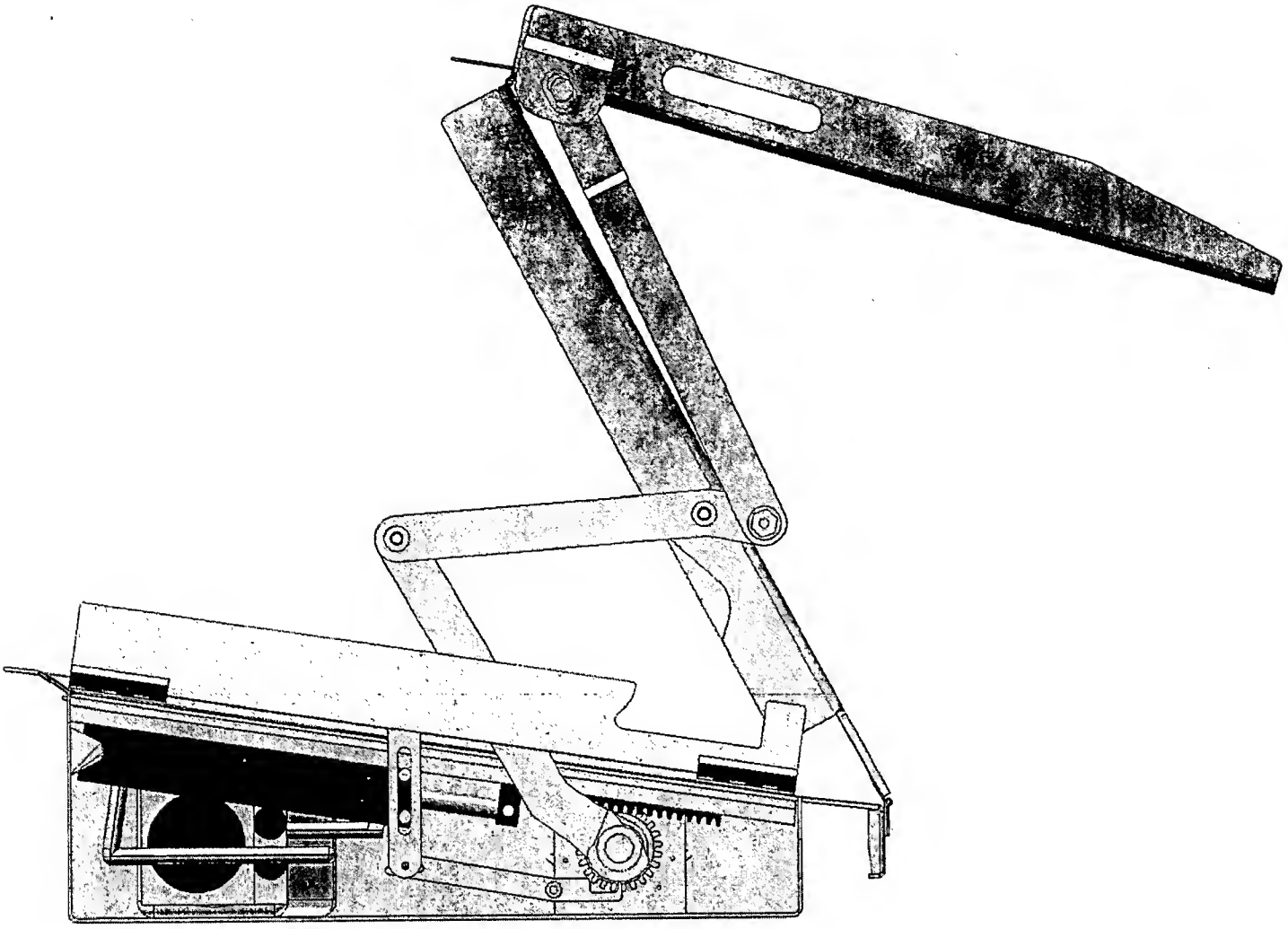


FIG. 6

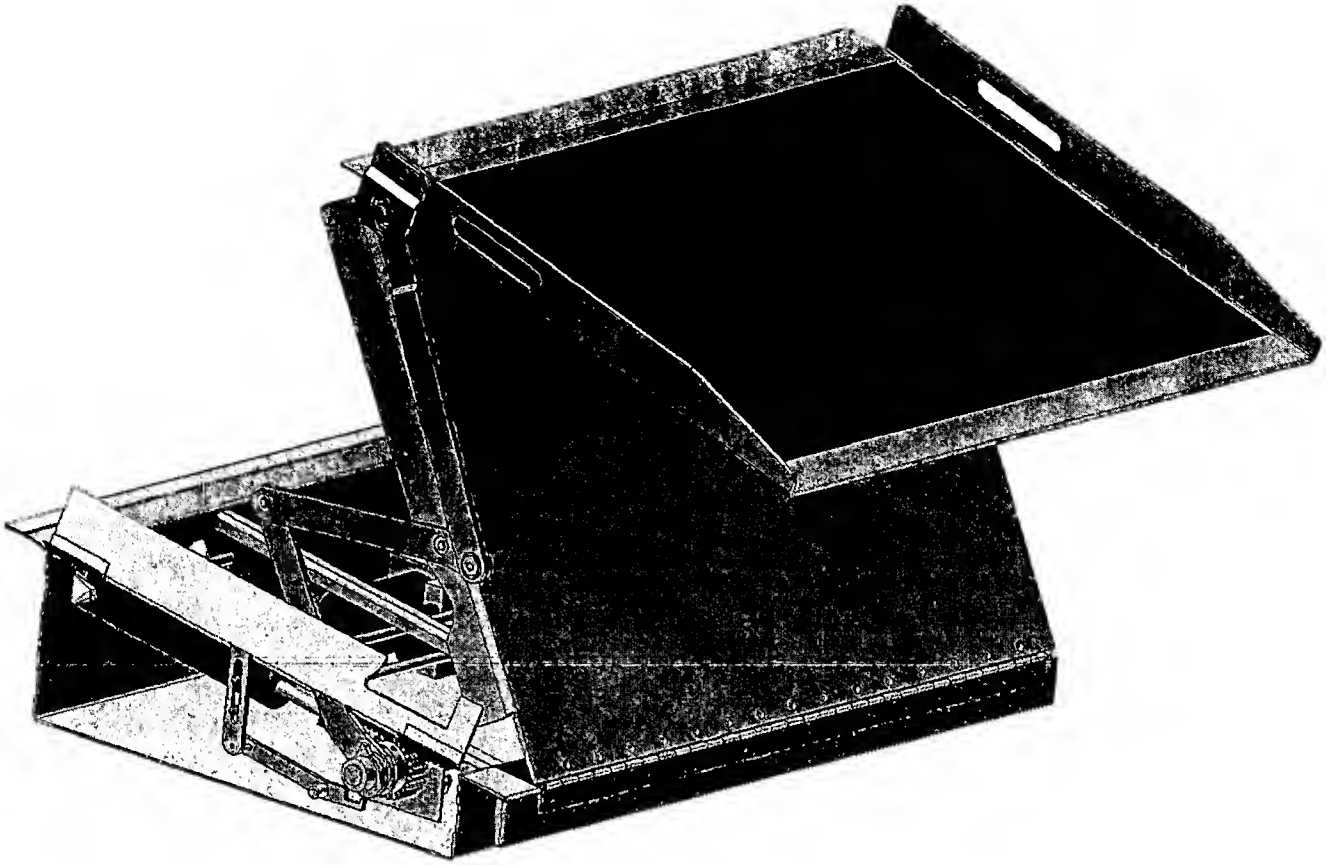


FIG. 7

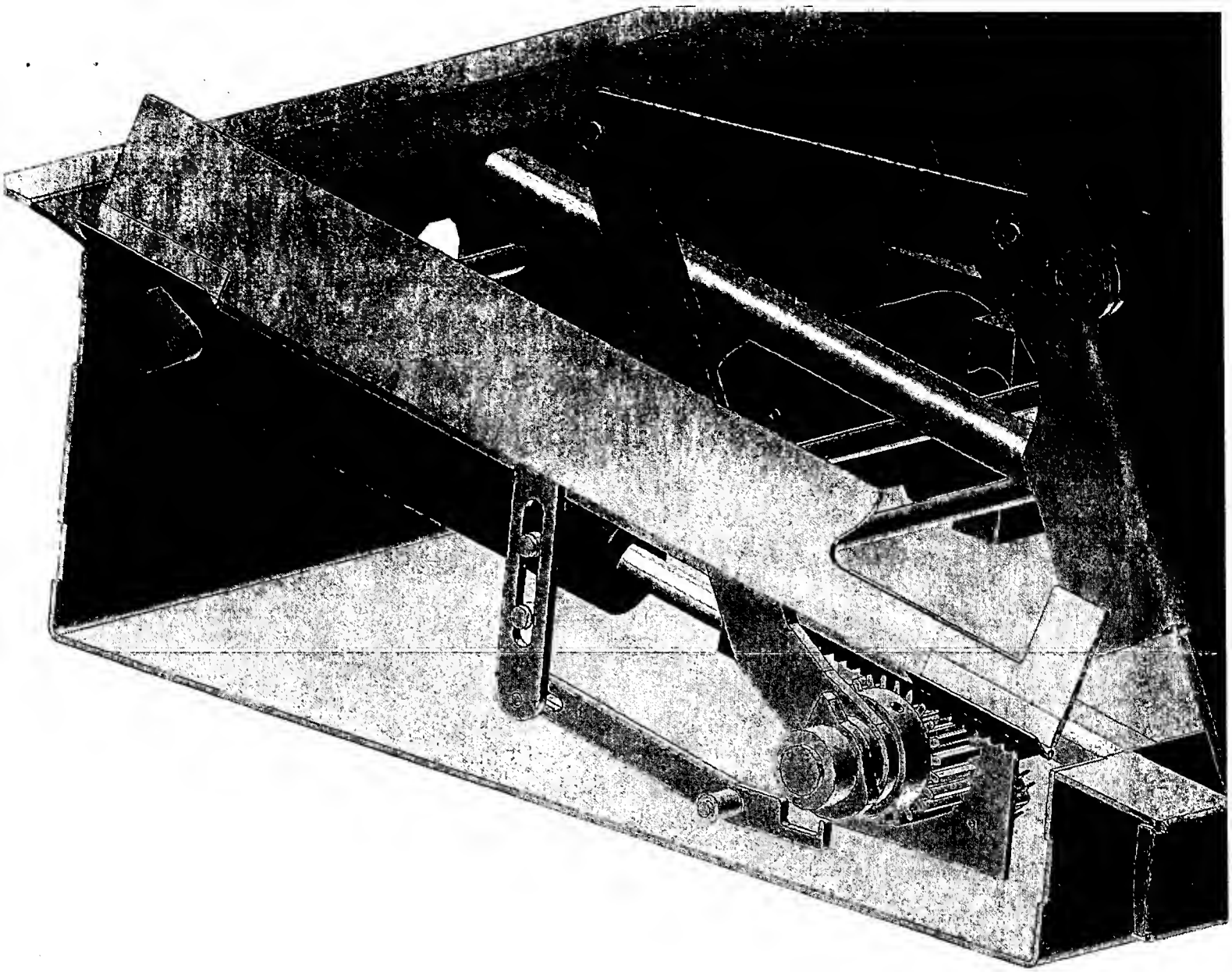


FIG. 8

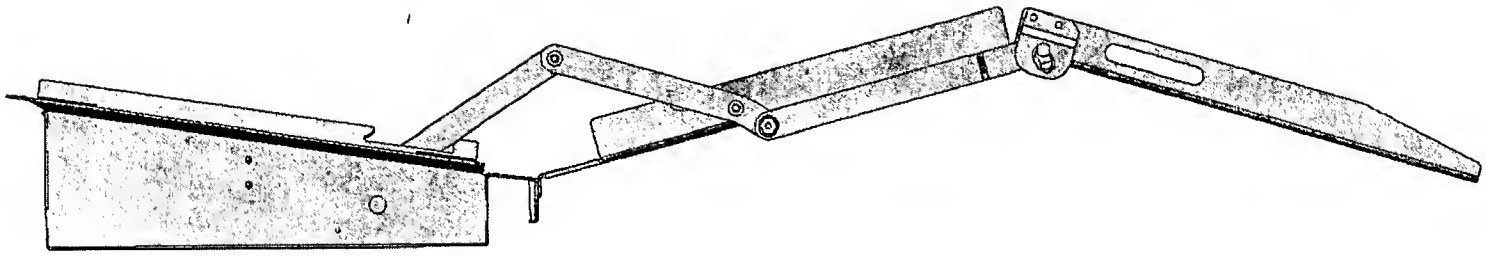


FIG. 9

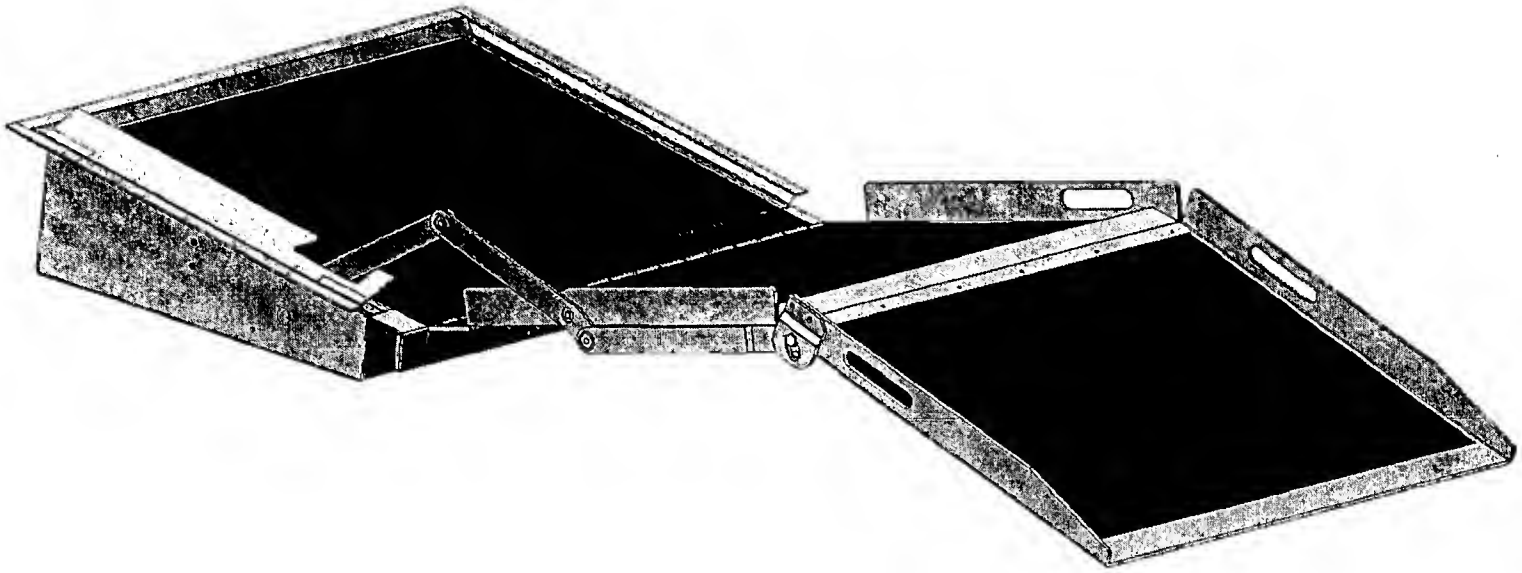


FIG. 10

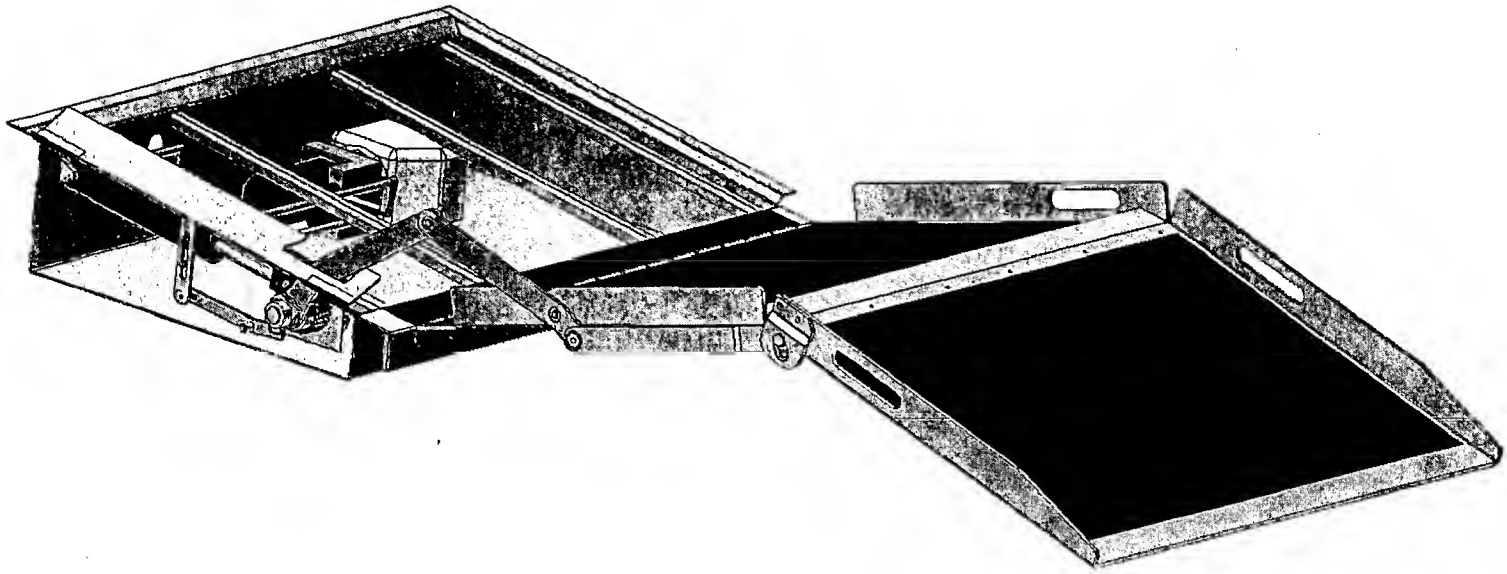


FIG. 11

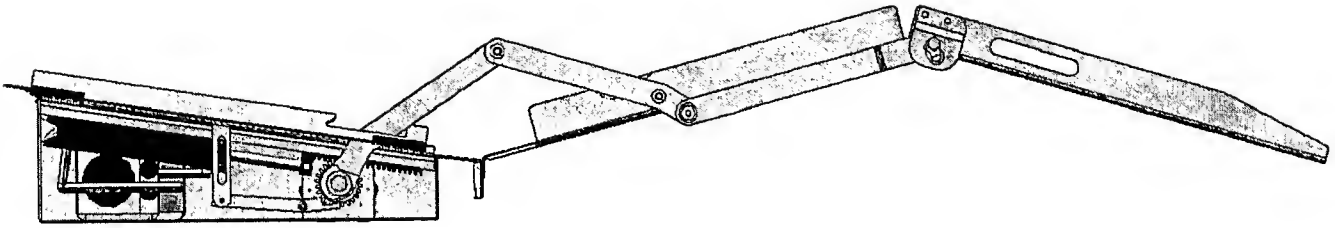


FIG. 12

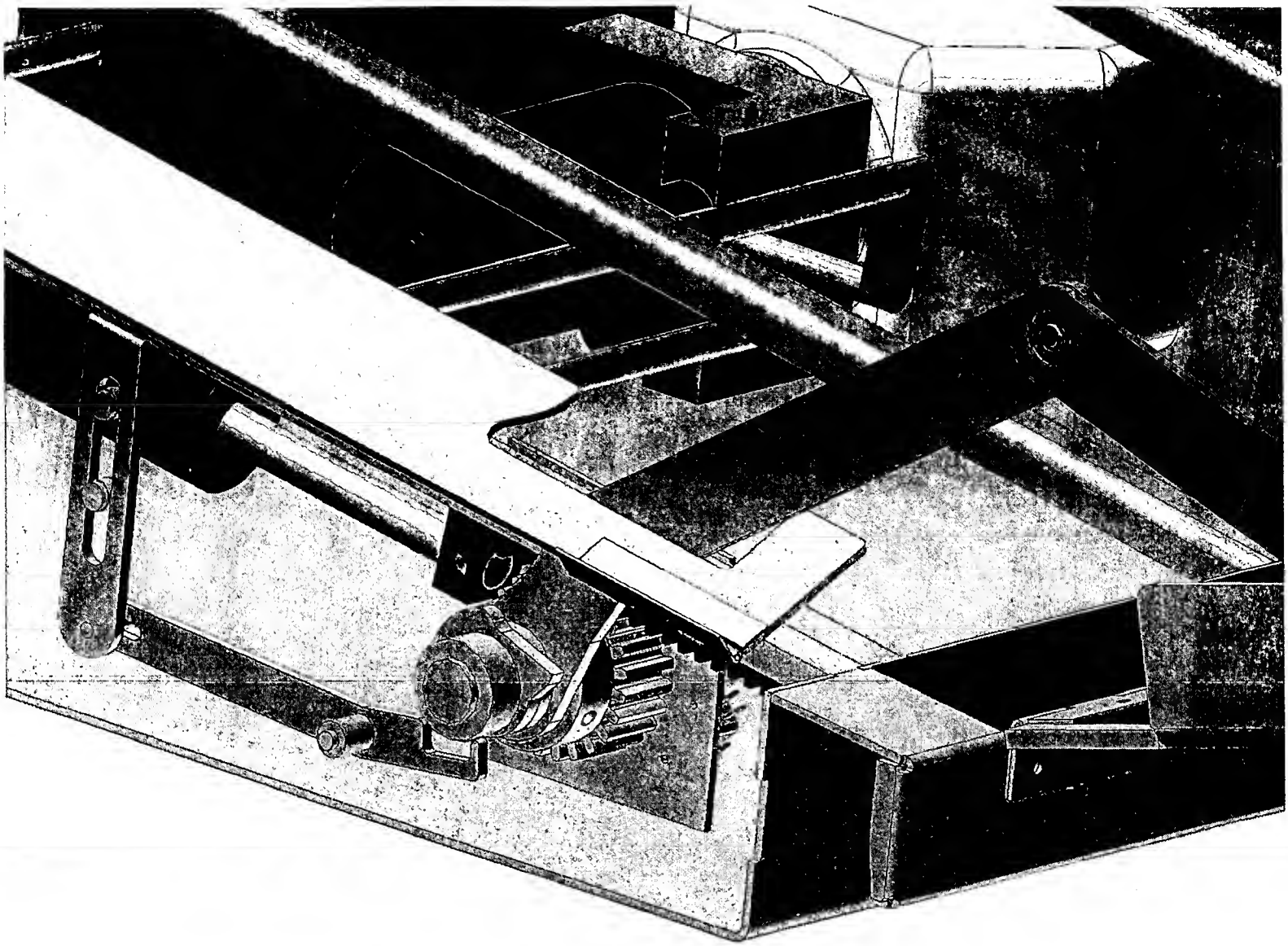


FIG. 13

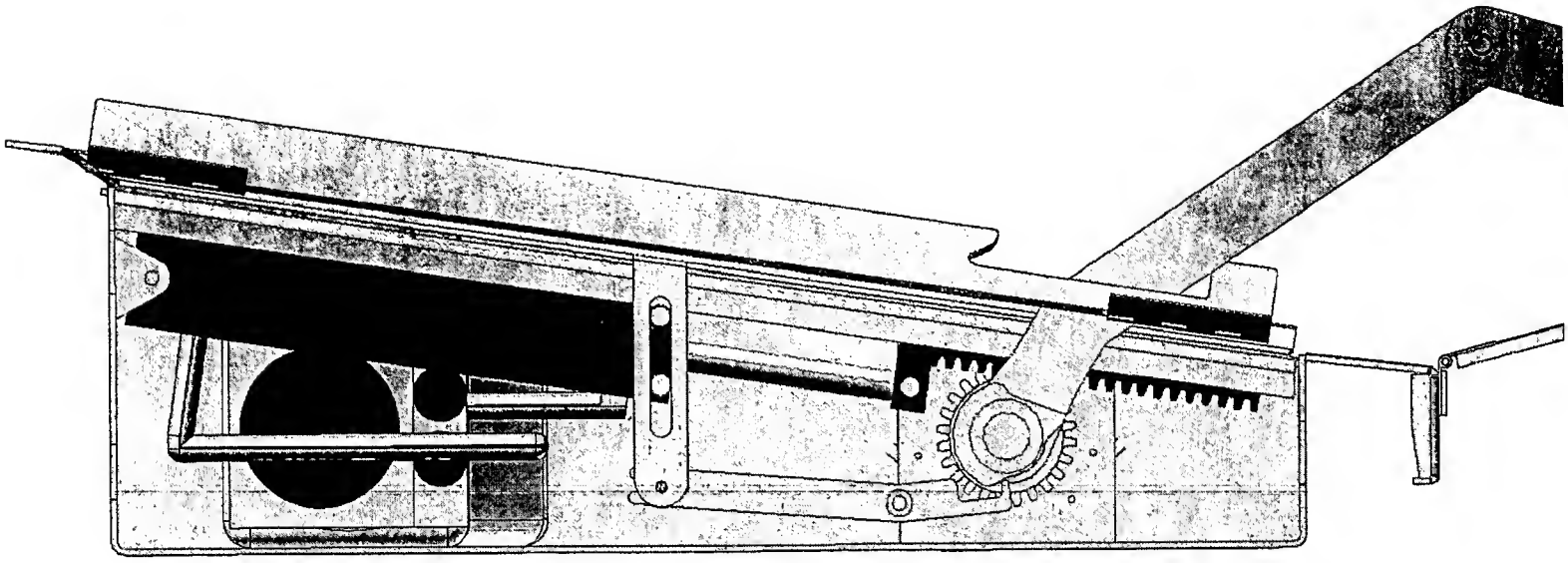


FIG. 14

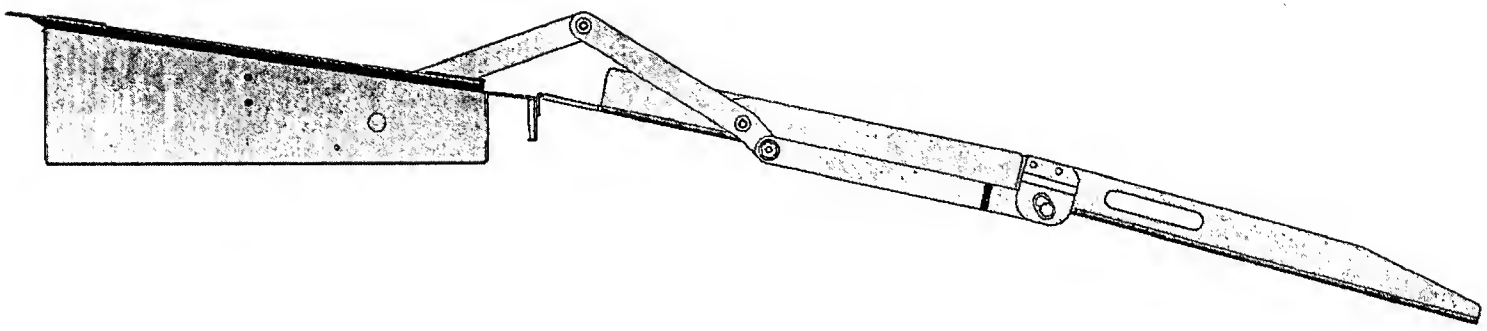


FIG 15

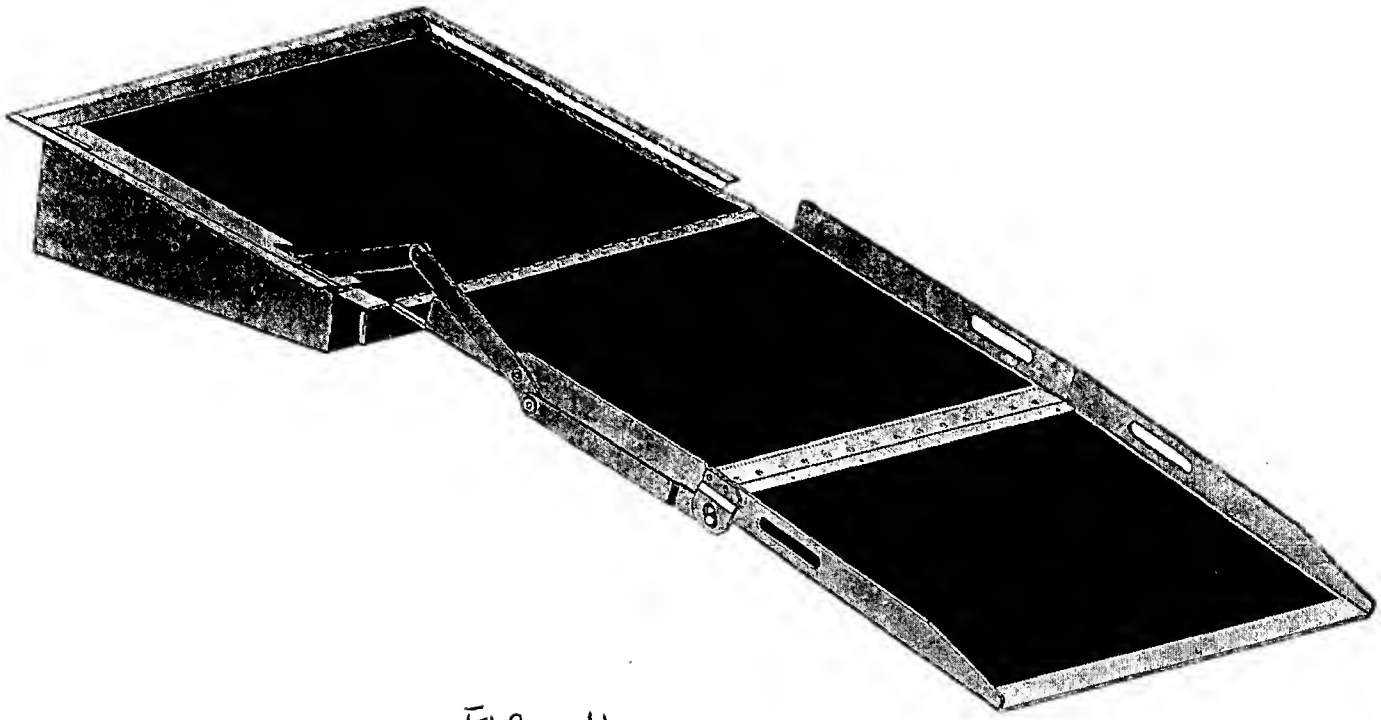


FIG. 16

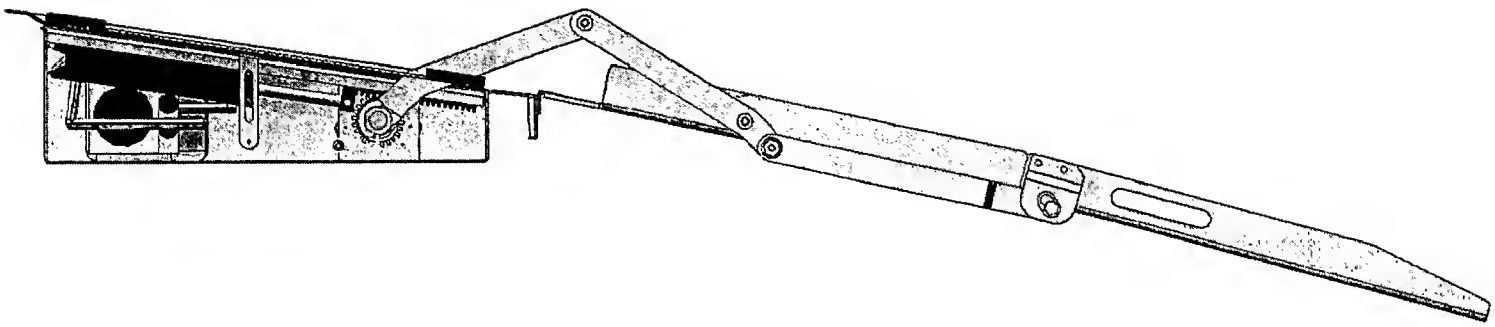


FIG. 17

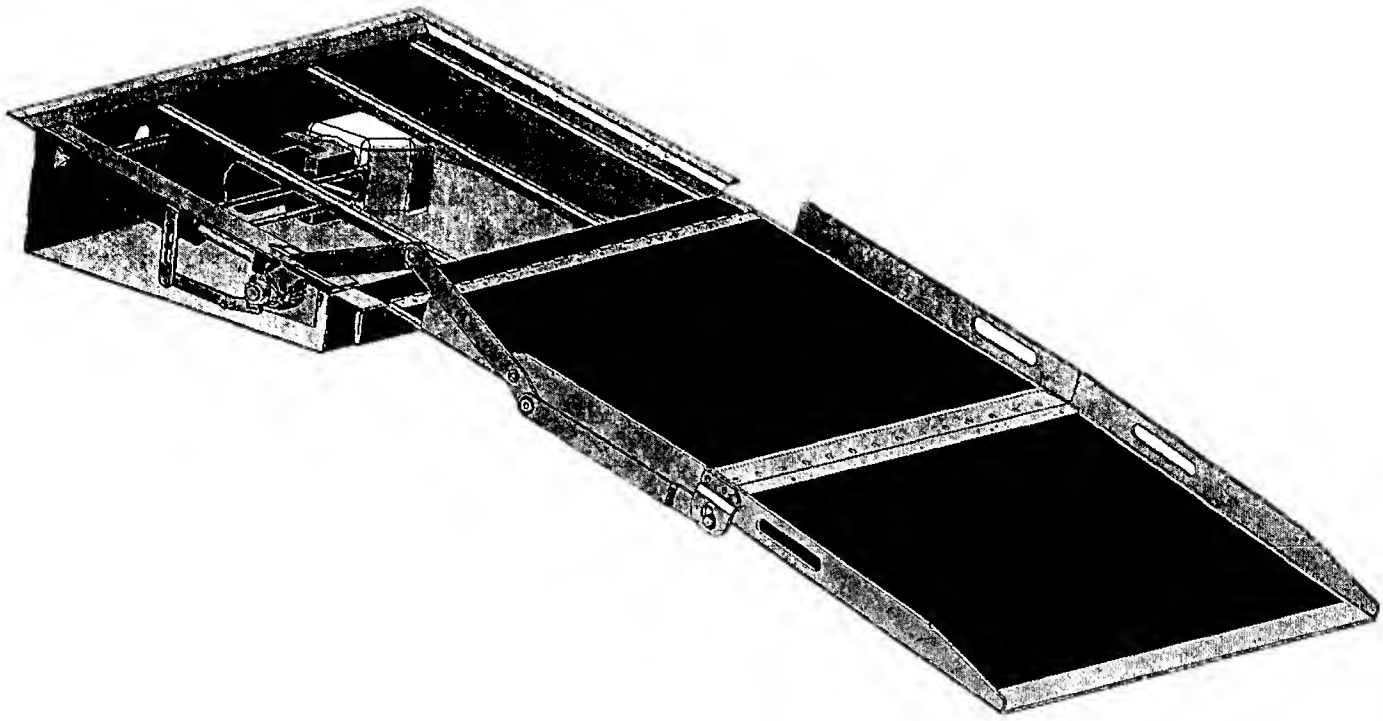


FIG. 18

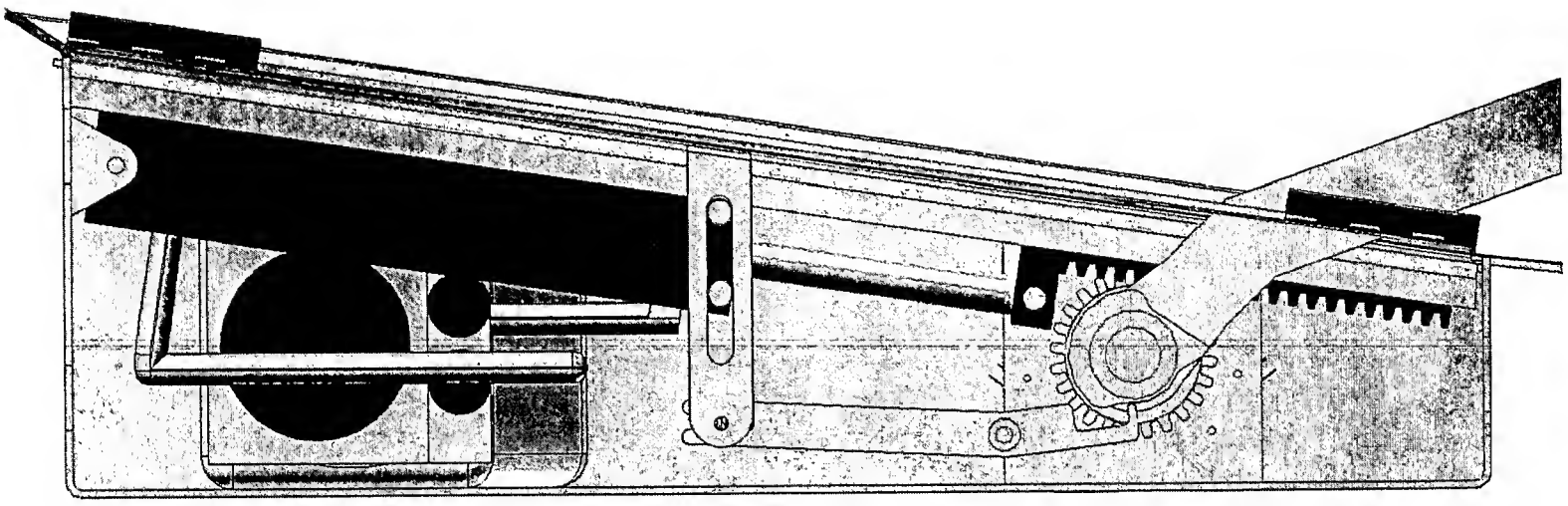


FIG. 19

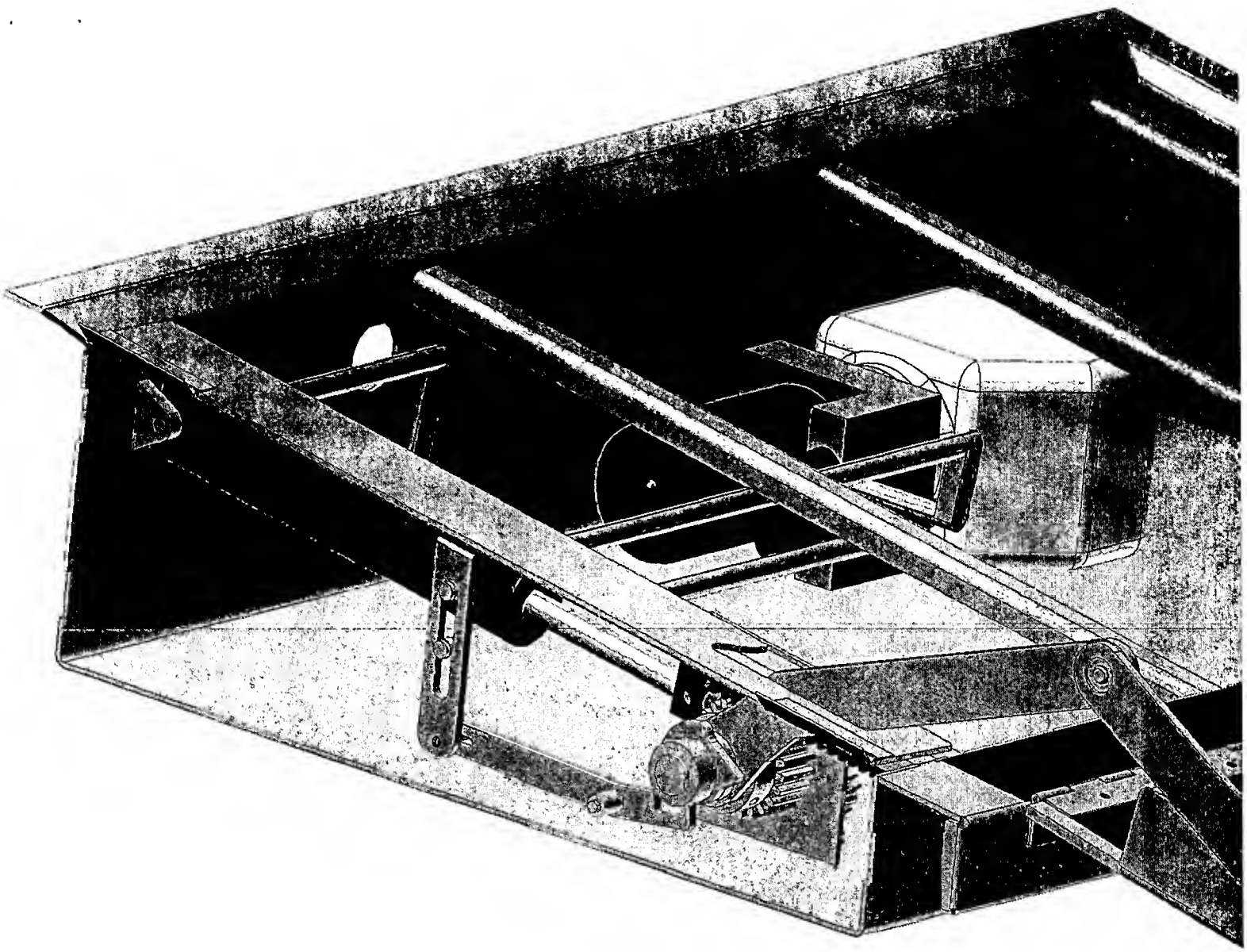


FIG. 20

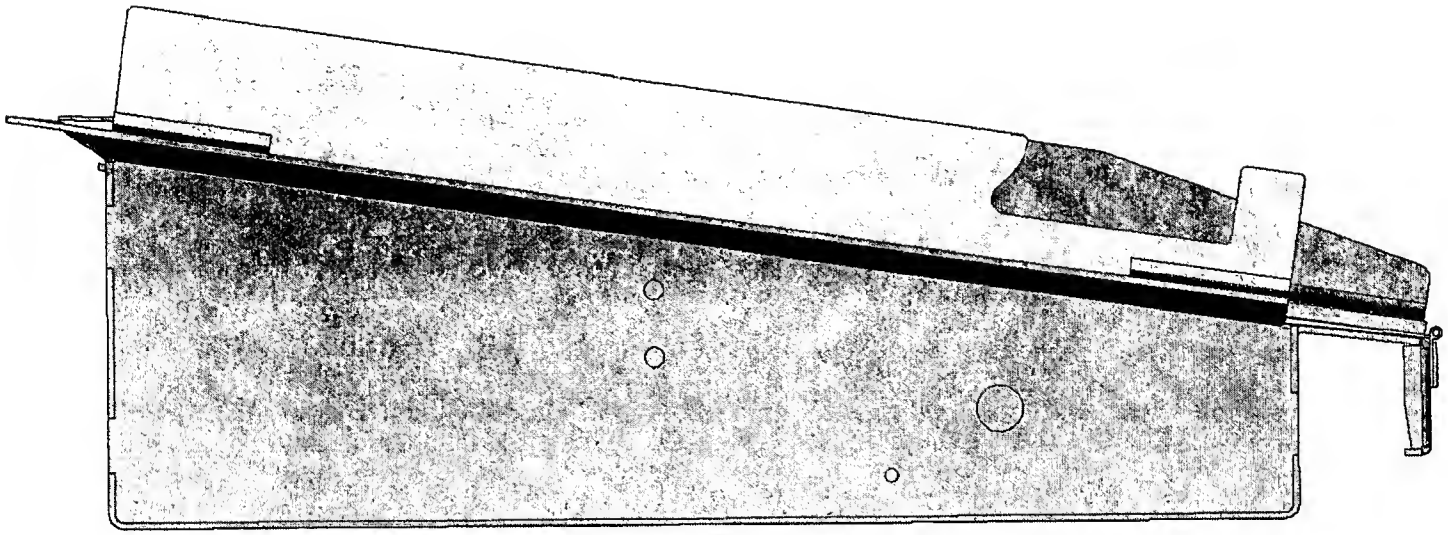


FIG. 21

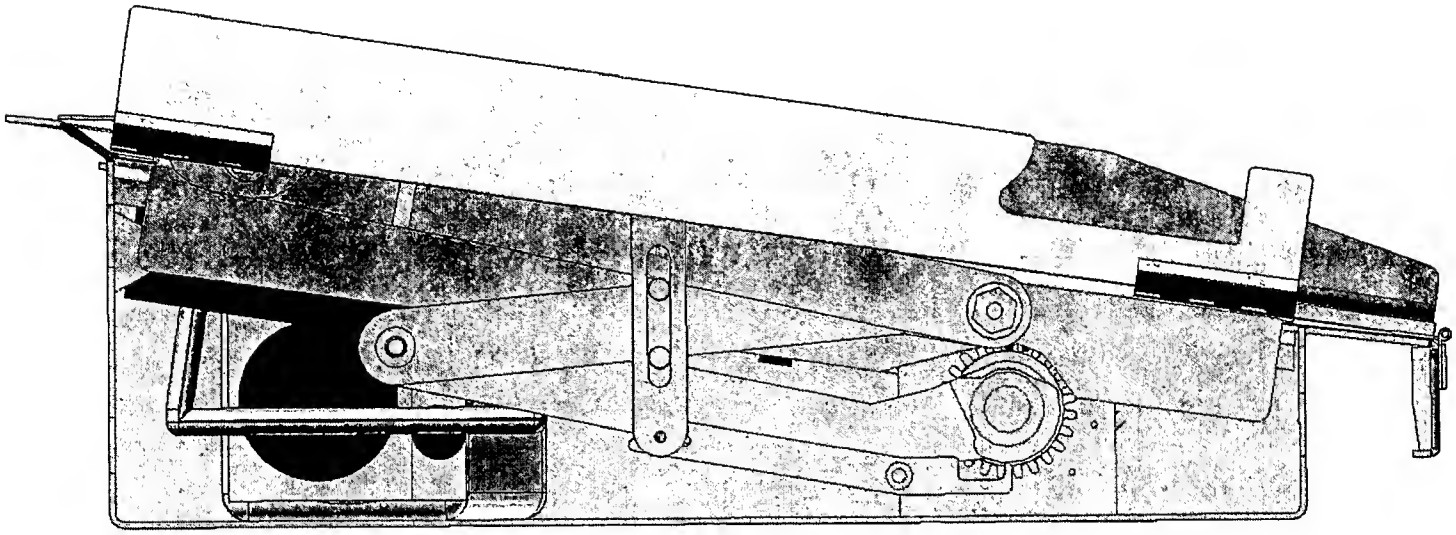


FIG. 22

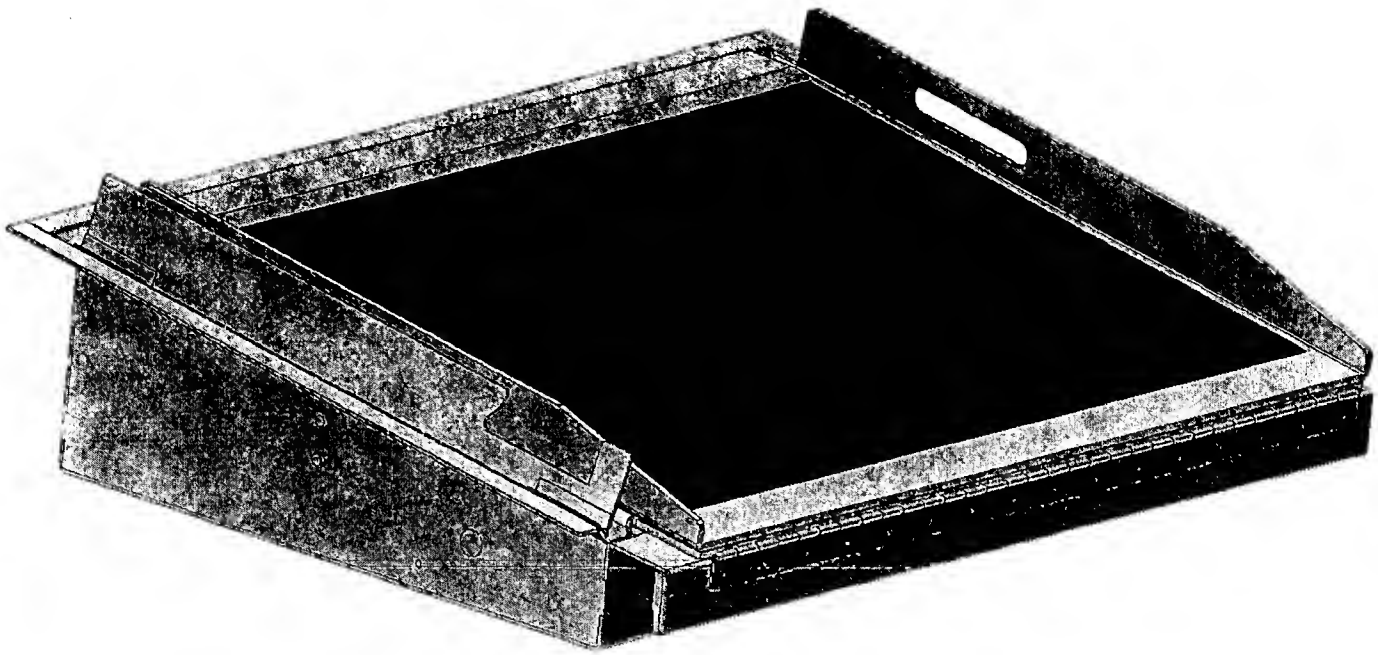


FIG. 23

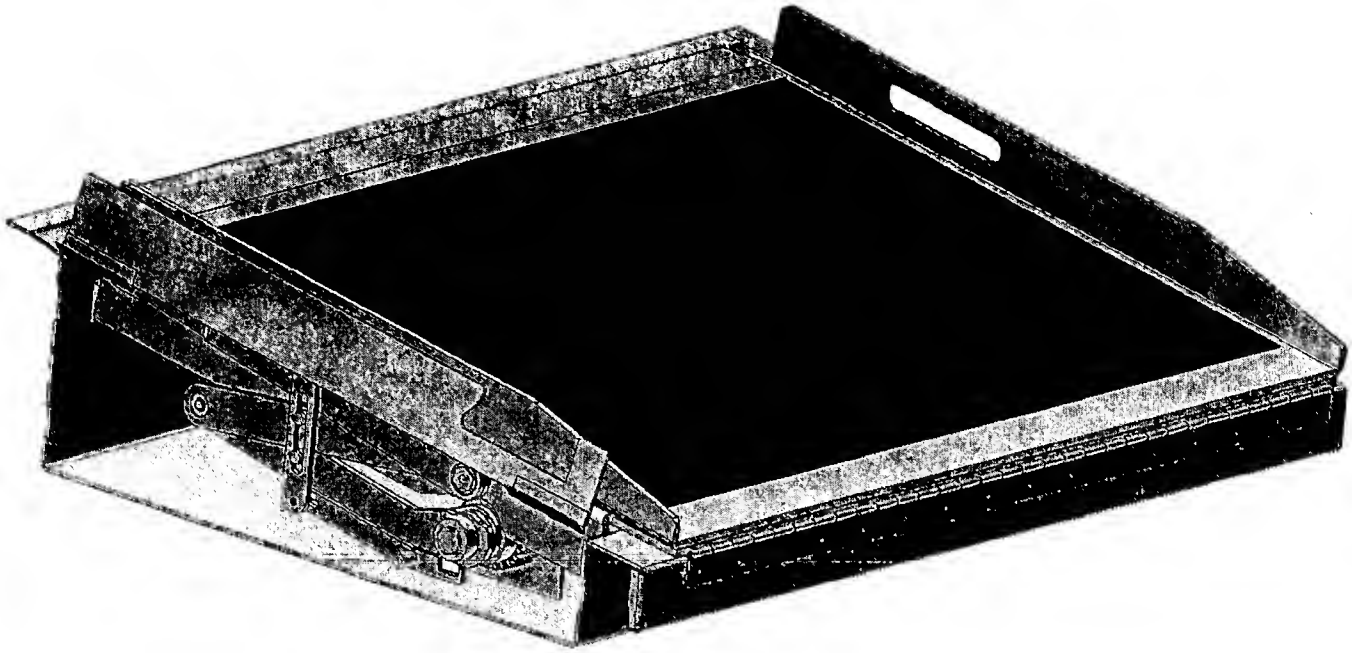


FIG. 24

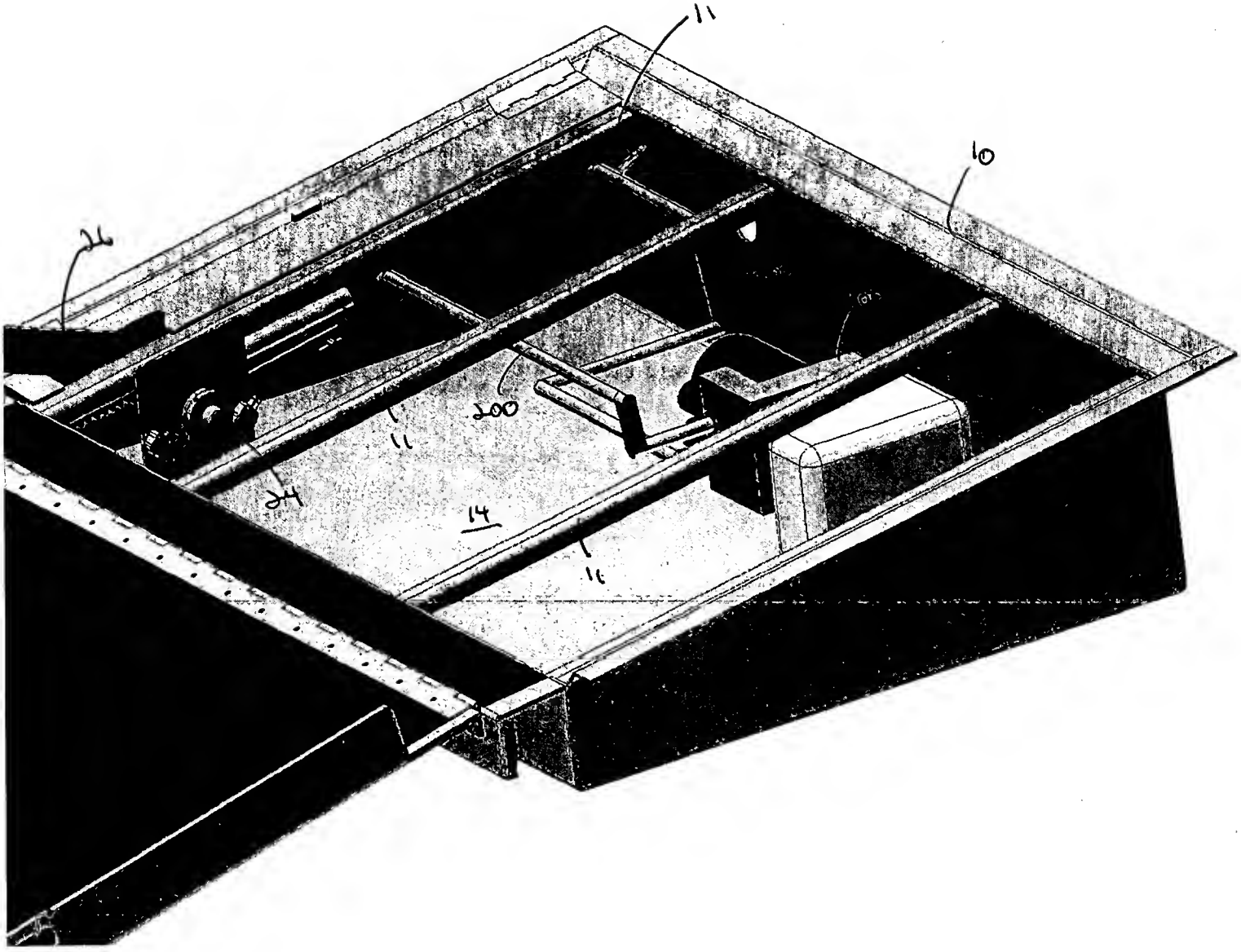


FIG. 2S

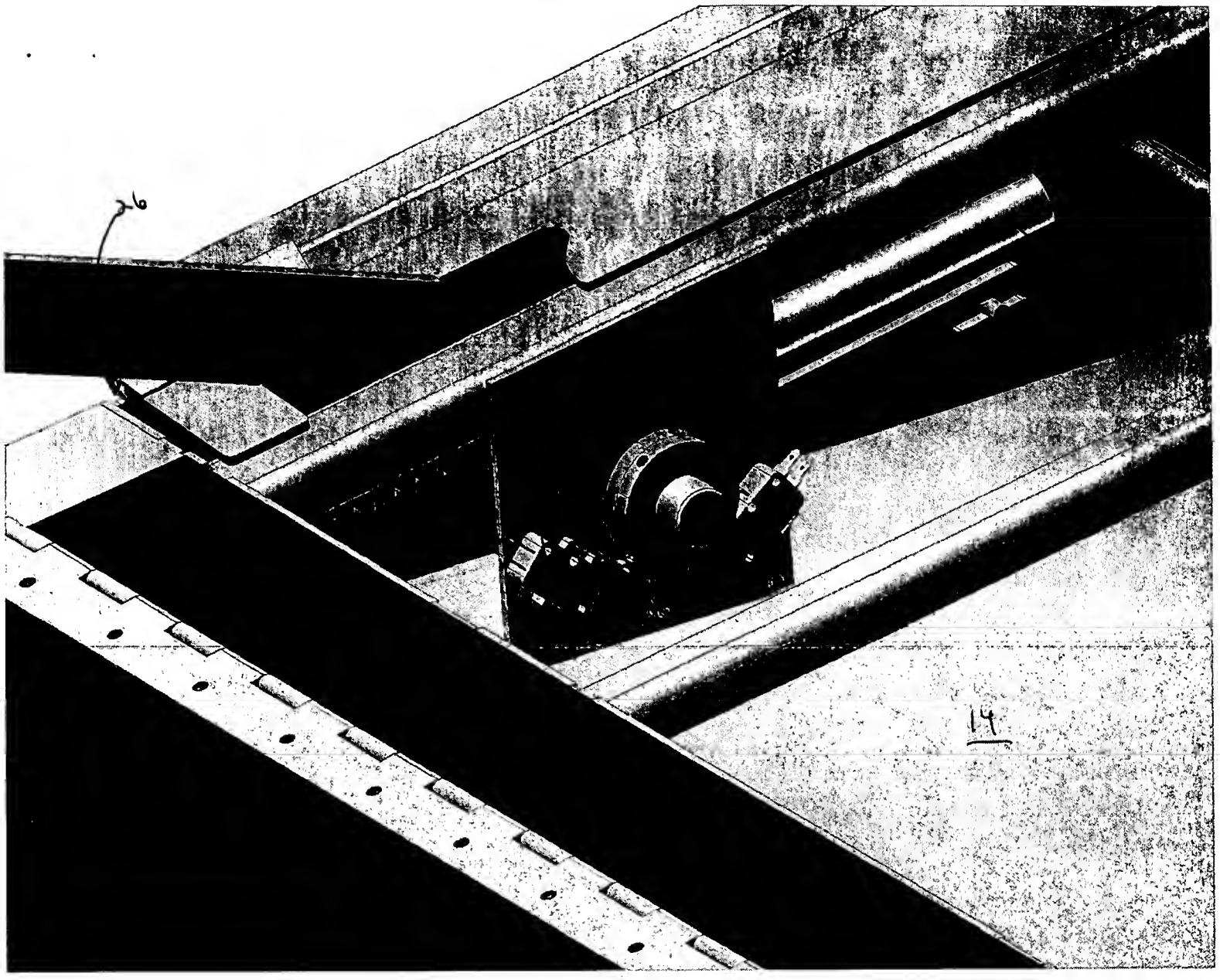


FIG. 26

FIG. 27

RAMP ELECTRICAL SCHEMATIC